Space Weather Technical Forecast

Issued on Saturday 30 November 2024 at 01:10 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance M-flares throughout. Slight Chance G1/Minor Geomagnetic Storm Day 3 or Day 4.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low during the past 24 hours, with the background irradiance trace remaining at C-class, with occasional flares. There are around nine active regions currently on the Earth-facing disc. The largest and most complex of these regions remains AR3905 and AR3906 in the southwest, with some interaction likely between the two regions. Although these regions have been largely inactive, AR3906 was responsible for the strongest flare observed during the period, a C5.5 at 29/2030 UTC. AR3912 may be one or two separate regions, with latest MOSWOC SRS splitting the region into two. The remaining regions are generally smaller and simpler, with no significant growth or decay observed.

No Earth-directed CMEs were observed during the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, measured by ACE and DSCOVR at L1, increased around 29/0200 UTC to slightly elevated levels following a CME arrival. Winds peaked around 450km/s before gradually declining back to slow-ambient levels from around 29/0900 UTC where they largely remained. A slight uptick in wind speeds was observed from around 29/2200 UTC with speeds at, or close to slightly elevated levels once more. Density started below average, but soon increased to average or slightly above average. Density then gradually declined back towards below average levels, until a second increase was observed around 29/1730 UTC with a peak of 21ppcc at 29/01917UTC with levels currently average. Total magnetic field strength increased from weak to moderate levels, reaching moderate levels due to the arrival of the CME at 29/0207UTC, briefly peaking at a strong level of 17nT at 29/0324UTC before easing to moderate levels. The north-south component Bz, initially varied weakly to moderately, although it has been mainly weakly positive. Since around 29/1740 UTC Bz has fluctuated moderately, tending towards a negative or southward orientation with a negative peak of -9nT. Phi angle was negative (towards the Sun), since 29/1740 UTC it has become predominantly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 0-2) throughout .

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background levels, with a brief diurnal peak at moderate levels. The associated 24-hour fluence

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remained well below the Active threshold. The integrated flux observed at 30/0000 UTC was 1.55e6 total pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with a chance of isolated M-class flares, and a very slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: A CME seen leaving the Sun on 27 Nov is forecast to arrive on Day 3 (02 Dec), or possibly Day 4 (03 Dec). This CME is forecast to either miss or glance the Earth, giving limited impacts. Solar winds are expected to remain at, or close to, slow-ambient levels throughout with CH96/+ forecast to be a weak feature, producing minimal enhancement.

Geomagnetic activity is expected to be mostly Quiet to Unsettled (Kp 1-3), although there is a chance of the glancing blow CME arrival producing Active (Kp 4) intervals, possibly peaking at G1/Minor Geomagnetic Storm (Kp 5) levels although this is considered a low likelihood.

Energetic Particles / Solar Radiation: High energy protons are expected to persist at background levels but with a slight chance of rising in response to any notable flares. High energy electron flux is expected to persist at mainly background levels with the associated 24 hour fluence remaining below the Active threshold.

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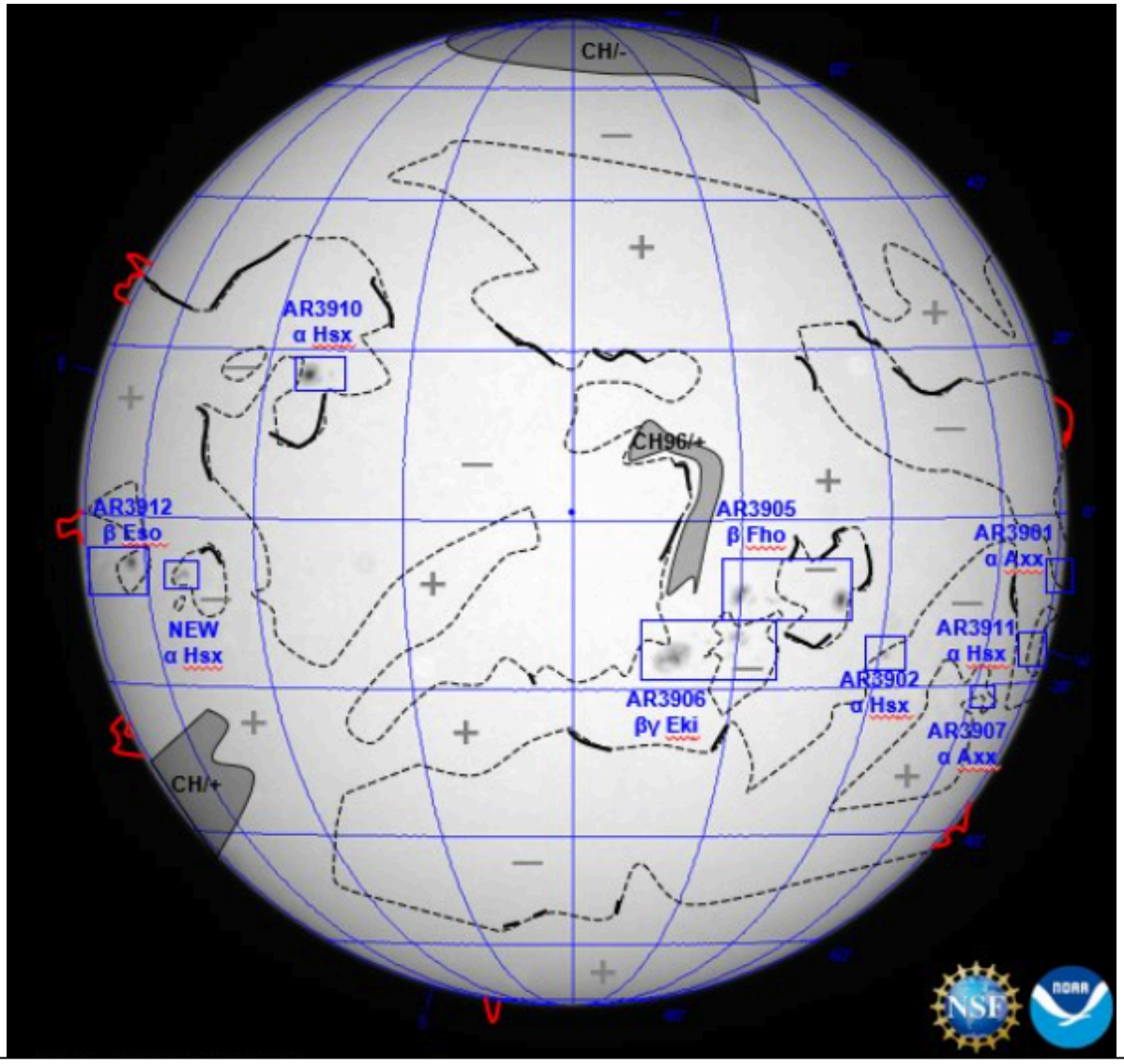
Figure 1: Solar Synoptic Map VT 29/2000 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

A filament eruption from the southeast disc around 27/1900 UTC has been analysed to have an Earth-directed component. This feature is slow and is expected to pass largely below Earth's orbit, but may give a weak glancing blow during Day 3 (02 Dec) or possibly Day 4 (03 Dec). A number of other CMEs have been observed in recent days, with modelling of two such events currently underway. However, these are all expected to miss Earth with moderate confidence in their trajectories.

A high speed stream associated with CH96/+, currently located near centre disc, may give a weak enhancement to solar wind strengths on 02 Dec. However, any enhancement is expected to be minimal and fleeting and may be masked by any glancing blow from the filament eruption CME. No other enhancements to solar wind speeds are expected, with SWPM and MOSWOC both considered to be providing a reasonable steer for the wind trend Days 2-4 (01-03 Dec), even if values are likely to remain at, or close to, slow-ambient levels throughout.

Quiet (Kp 0-2) geomagnetic activity is expected to prevail with a chance of occasional Unsettled (Kp 3) through much of the forecast period. There is a slight chance of the aforementioned glancing blow CME arrival Day 3 or possibly as late as Day 4, temporarily increasing activity to Unsettled to Active (Kp 3-4), with a slight chance of a G1/Minor Geomagnetic Storm interval if this should combine with any weak HSS enhancement.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
28/11/2024 04:28	Partial	Filament	SE	390	02/12/2024 14:00 UTC	Low confidence glancing blow. Minimal impact.

Figure 2: MOSWOC SWPM giving reasonable steer for trend.

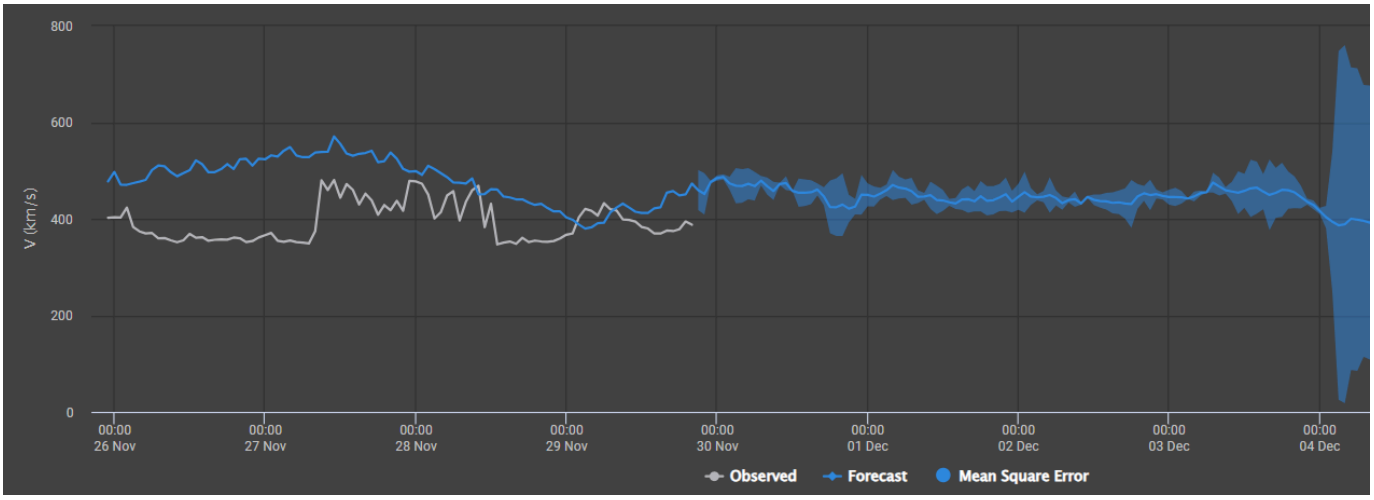

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Figure 3: MOSWOC Enlil. Winds considered reasonable by Day 2.

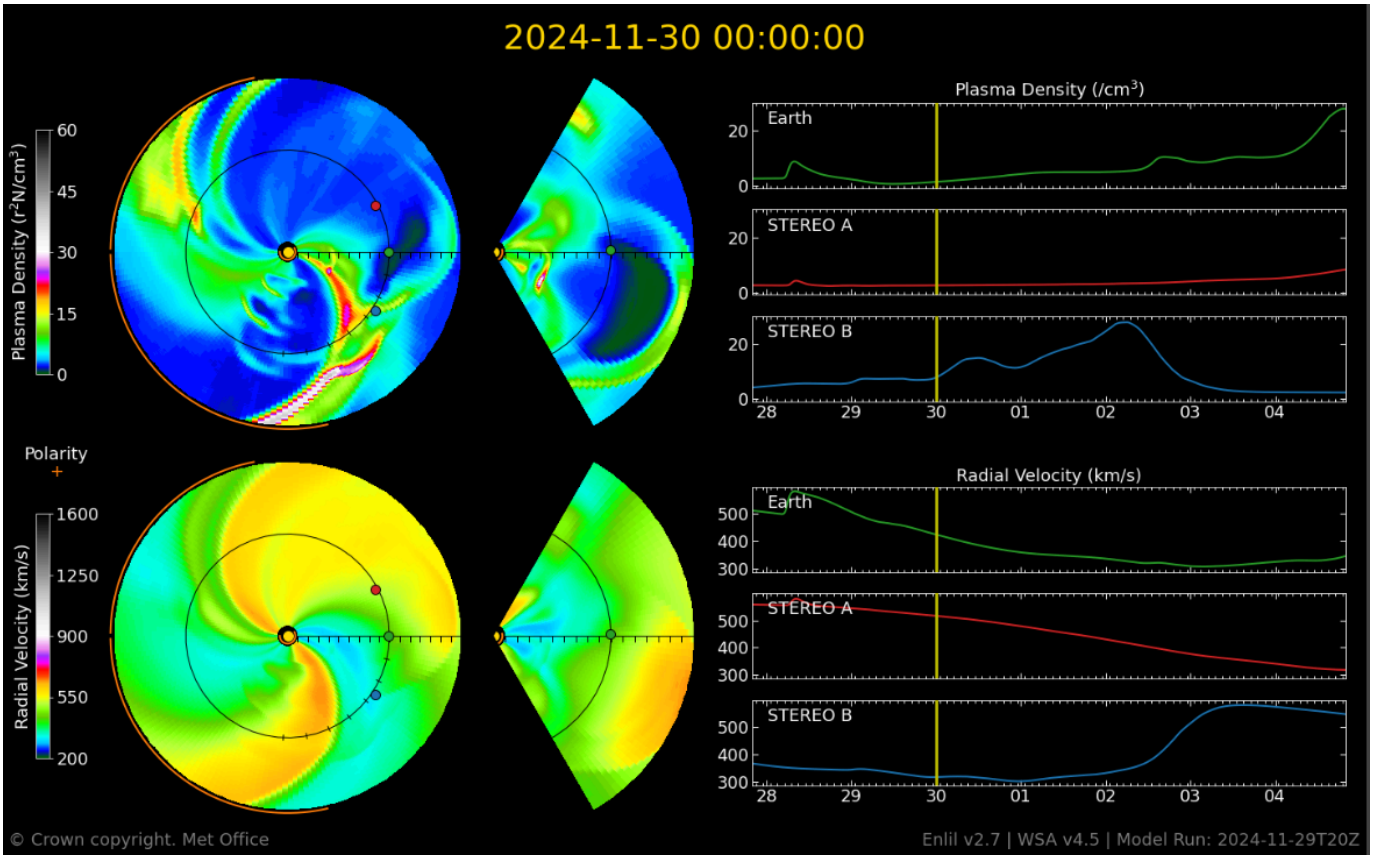
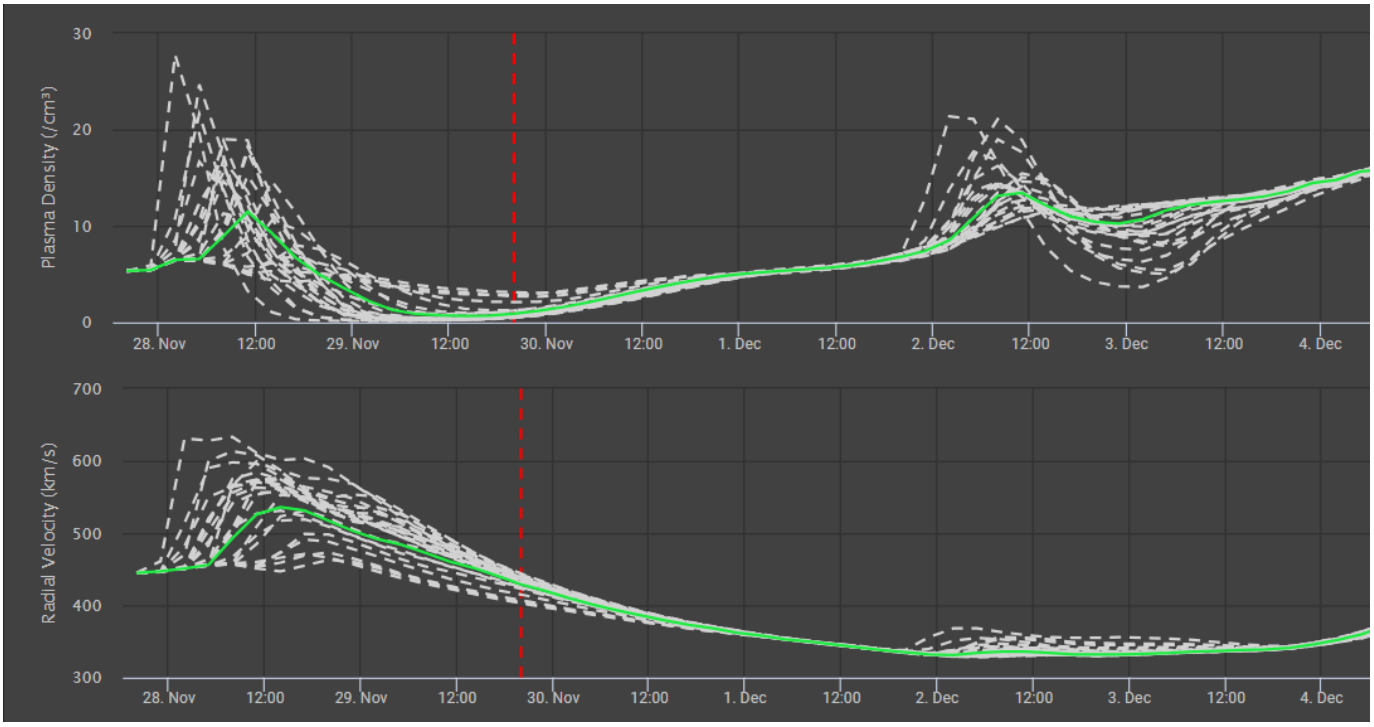


Figure 4: MOSWOC Enlil Ensemble



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Radio Blackouts - X-Ray Flares

Low to Moderate activity is expected with an ongoing chance of isolated M-class flares, and a very slight chance of X-class flares.

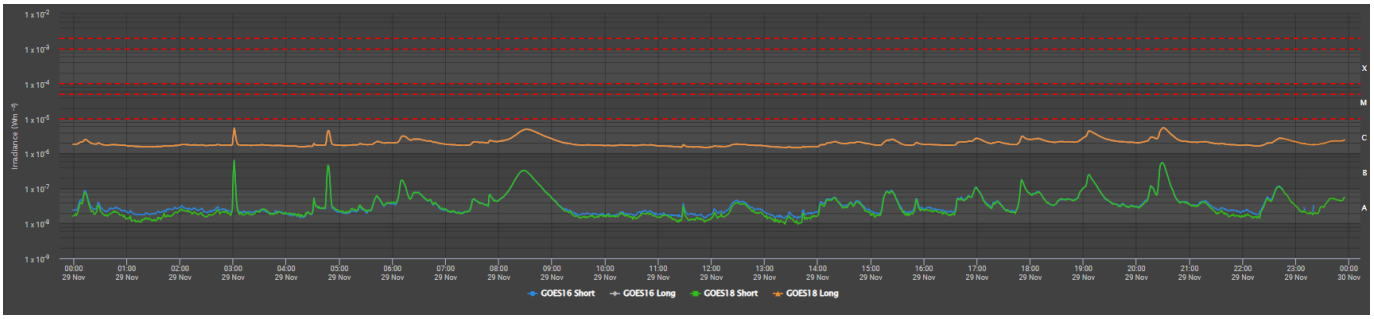
There are nine active regions currently on the Earth-facing disc, although AR3901 is no longer visible due to its location in close proximity to the western limb. The largest regions remain AR3905 and AR3906, both in the southwest, with some interaction likely between the two closely located regions. The only other region(s) of note is AR3912, in the southeast. This region has been split into two separate groups regions, the leading portion has been reclassified as an unnumbered Hsx region, with the trailing portion taking on the label of AR3912. As a result, there may be some discrepancy between descriptions of the region. This may change with later analysis as the region or regions rotate into a better viewing angle.

The other regions are generally smaller and simpler. No significant growth or evolution of the active regions on the visible disc was observed over the past 24 hours. However, assessment of sunspot regions is currently more challenging than usual with limited imagery due to the fact that SDO imagery and data is offline.

No notable regions are expected to depart during the period. Flaring has been observed from a region just beyond the eastern limb appearing to emanate from an area of brightness visible on GOES-16 SUVI 94 and 304 imagery. During the forecast period new or returning regions are expected to rotate onto the visible disc, therefore the probabilities of significant flares may increase.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	40	40	40	40
Very Active	R3-R5 (X Class)	No	2	2	2	2

Figure 5: GOES16 and GOES18 24 hour X-Ray trace.



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Solar Radiation Storms (High Energy Protons)

GOES-18 Proton flux is at background levels. As AR3905 and AR3906, the two most magnetically active regions, continue to rotate across the western hemisphere the chance of solar radiation storms has increased slightly. However, these regions have not shown any notable flare activity in recent days resulting in only a slight chance of observable high energy protons being ejected.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	0
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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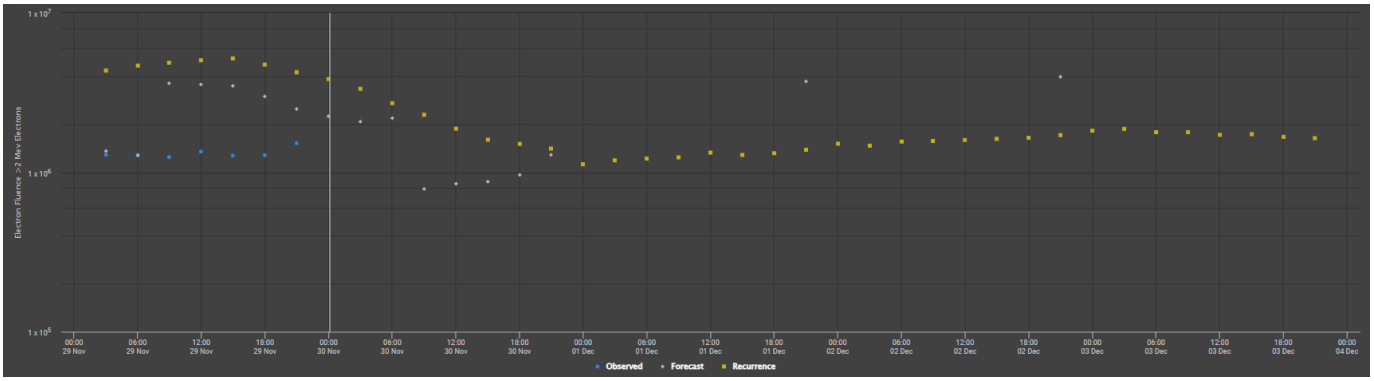
High Energy Electrons (≥ 2MeV)

High energy Electron flux observed by GOES-16 is at background levels, with only a weak coronal hole present on the disc with no significant enhancements currently anticipated. A potential glancing blow from a CME that left the Sun on the 27 November is expected to arrive on 02 December, this may see electron flux levels become suppressed as the Van Allen belt compresses before expanding again after the forecast period.

The associated 24 hr fluence is expected to persist below Active, with MOSWOC REFM recurrence currently considered to be providing good guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 6: MOSWOC REFM



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